Labs for the 21st Century
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Step-Variable Air Volume Fume Hood Control Case Study

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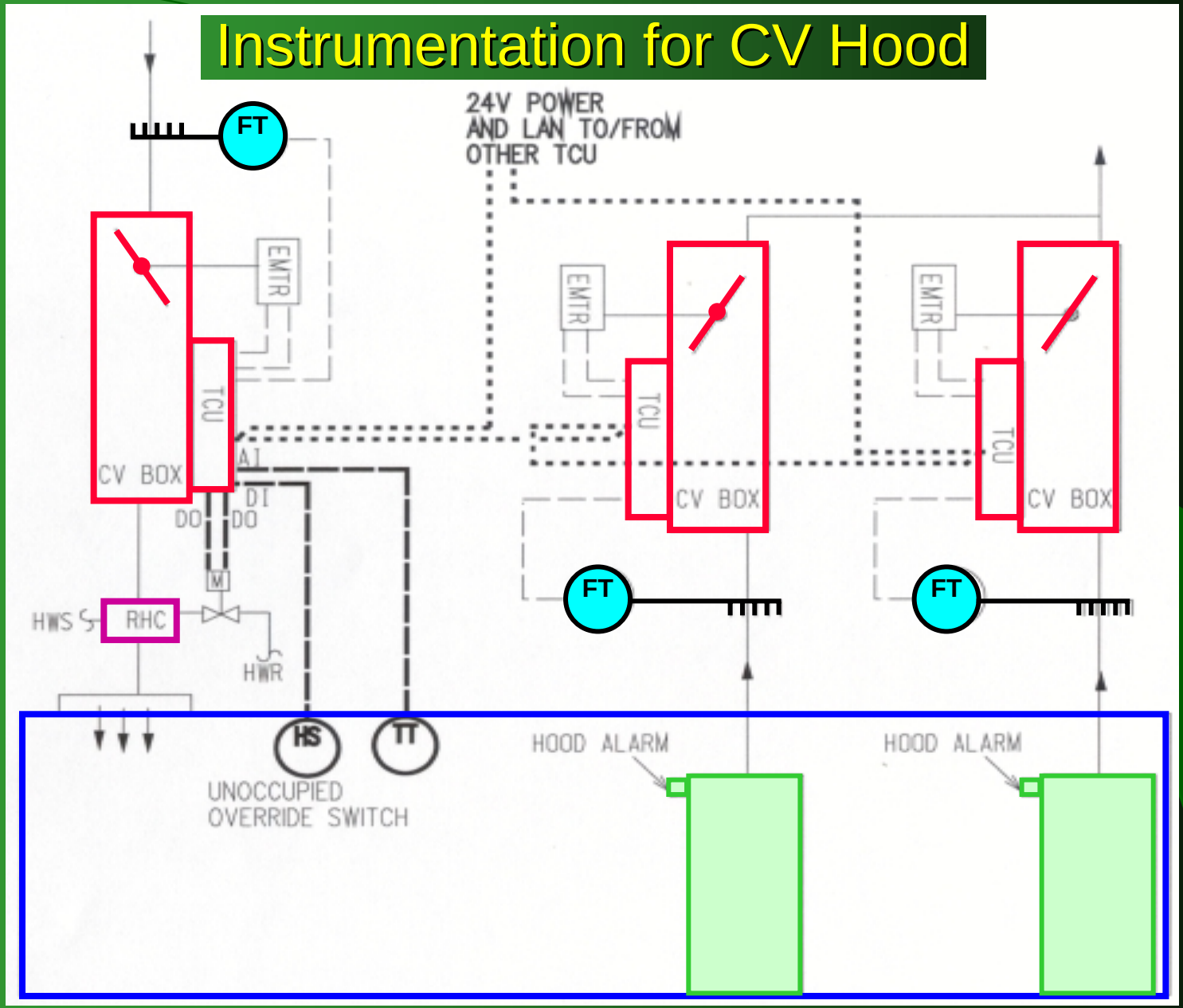
Design Challenge: Lab Fume Hood Control

- Fume Hoods
  - Critical Elements In Lab Design and Operation
  - Significant Impact On Lab Construction and Operating Costs
- Strategy
  - Constant Volume Vs. Variable Air Volume
- Cultural Issues

Constant Volume Fume Hoods

- Hood sashes are physically connected to “bypass dampers” that are reverse acting with position of sashes
- Provides constant exhaust flow through fume hood regardless of sash position
- CV fume hoods are high energy users … no reduction in exhaust airflow as sashes are closed
- No complex instrumentation

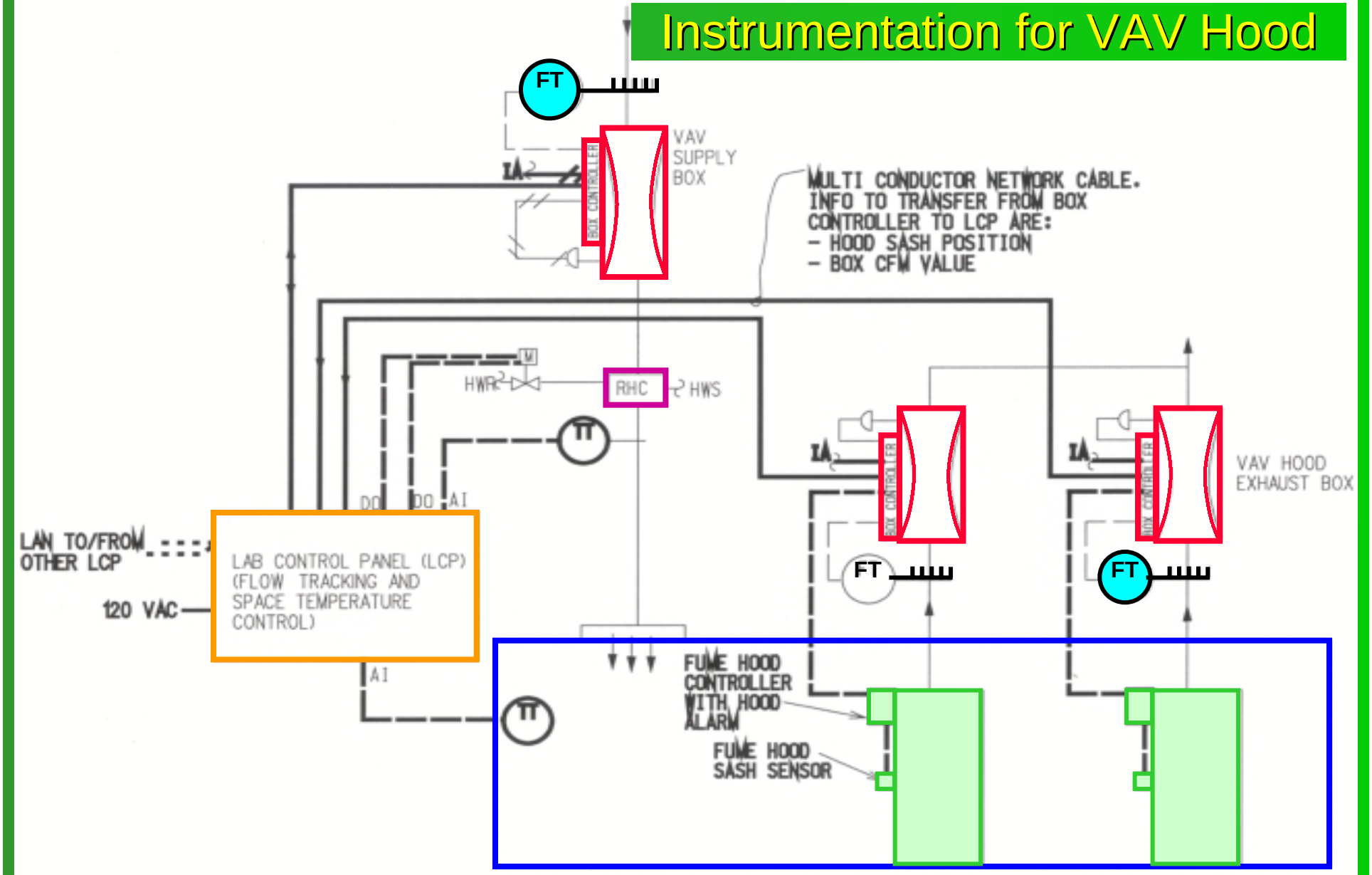
Instrumentation for CV Hood



Variable Air Volume Fume Hoods

- Controls vary exhaust airflow through hood based on sash position
- Airflow varied to maintain constant face velocity through open sash area
- VAV fume hoods provide energy saving opportunities via reduced airflows when sashes are closed
- Requires complex instrumentation

Instrumentation for VAV Hood



STEP-VARIABLE AIR VOLUME FUME HOOD CONTROL

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CV vs. VAV INSTALLED COST COMPARISON

- Constant Volume Hood Control Installation
  - Terminal Exhaust Box Controller $2,000
  - Terminal Supply Box Controller $2,000
  - Hood Alarm $1,000
  - Unoccupied/occupied Override Switch $500
  - Total $5,500

- Variable Air Volume Hood Control Installation
  - Fume Hood Controller With Sash Sensor, Hood Alarm Panel and Exhaust Box Control $8,000
  - Lab Control Panel With Flow Tracking, Supply Box and Room Temperature Control $7,000
  - Total $15,000

Case Study

- 65,000 GSF Chemical Development Facility
- Approx. 75 fume hoods with four horizontal sashes
- 100 FPM face velocity through open sash area
- Typical 735 square foot lab module
  - Four 8 ft benchtop
  - Two 8 ft walk-in hoods
- Diversity Per module
  - Two (2) benchtop hoods at 50% open
  - Two (2) walk-in hoods at 50% open
  - Remaining hoods closed
- Scientists have bias against VAV
- Facility operations want to see energy savings
- Owner PM wants to see first cost savings

Design Challenge

Challenge:

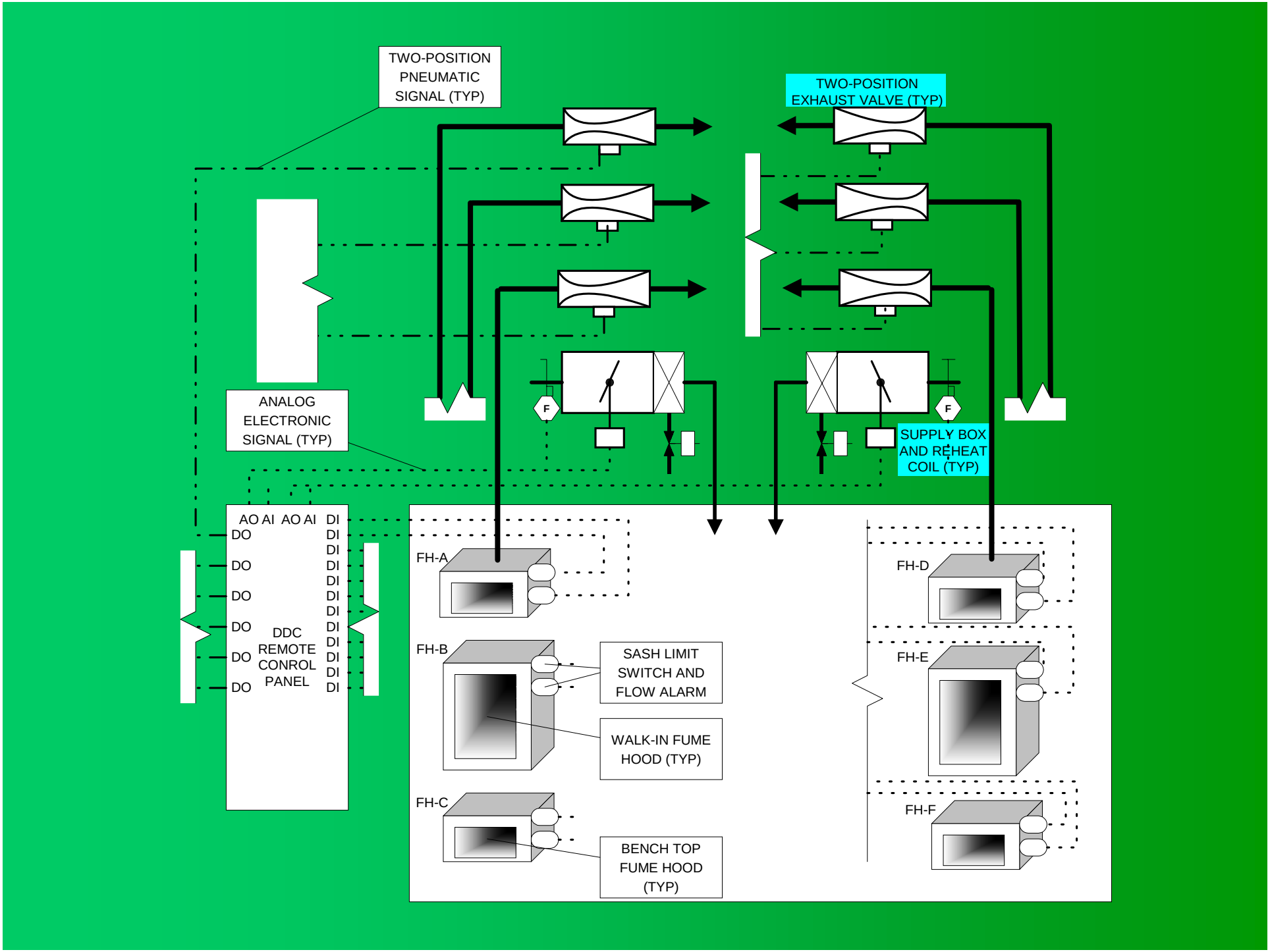
- Provide System That Reconciles Low First Cost and Low Operating Cost With Cultural Bias Against VAV?

Solution:

- Step-Variable Air Volume Fume Hood Control

Step-Variable Volume Fume Hood Control

- Two-position constant volume box installed in exhaust duct serving the fume hood
- Each sash door furnished with door switch that "closes" when all sashes are shut
- Controls provided to index two-position exhaust box to its low setting when door switch contact closes, indicating that all sashes are closed
- Supply boxes serving the lab module programmed to "track" with position of exhaust boxes
- Lab/hood airflow and space temperature can be monitored and controlled by typical building management systems (BMS) – proprietary controls are not required


TWO-POSITION PNEUMATIC SIGNAL (TYP)
TWO-POSITION EXHAUST VALVE (TYP)
ANALOG ELECTRONIC SIGNAL (TYP)
SUPPLY BOX AND REHEAT COIL (TYP)
F
F
AO AI AO AI
DO
DO
DO
DO
DO
DO
DDC REMOTE CONROL PANEL
DI
DI
DI
DI
DI
DI
DI
DI
DI
DI
FH-A
FH-B
FH-C
FH-D
FH-E
FH-F
SASH LIMIT SWITCH AND FLOW ALARM
WALK-IN FUME HOOD (TYP)
BENCH TOP FUME HOOD (TYP)

Sequence Of Operation – BMS Functions

- Monitors hood sash positions via sash end switch
- When sashes open, indexes exhaust box to high setpoint
- When sashes close, indexes exhaust box to low setpoint
- Sums exhaust from two-position CV exhaust boxes serving lab, then adjusts supply box to track with fume hood exhaust
- Limits exhaust per module based on design diversity
- Local visual / audible alarm in each lab … when too many sahes are opened
- Maintains space temperatures by modulating reheat coils based on room thermostats and exhaust duct mounted temperature sensors (cascade control)

Step VAV Features and Benefits

- Step –VAV control provides the benefits of VAV at less cost with less complex instrumentation
- Fast control response time
- Control is more “robust” than traditional VAV
- Airflow control is provided by time proven BMS technology
- Better match to the “real world” usage of fume hoods

Summary

- Step-VAV minimizes capital costs when compared with traditional VAV
- Step VAV reduces operating costs by allowing setback of hoods whenever sashes are closed
- Fundamentally simple two-position control
- Controls used are proven technology
  - Uncomplicated
  - Easy to maintain
- Step –VAV control combines best features of CV and VAV controls while avoiding some perceived disadvantages

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